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AUTHOR Kleban, Morton H.; And Others
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ABSTRACT

This paper explores Q-Factor Analysis as a method of organizing data on a large array of variables to describe a group of aged Ss. Forty-seven males, specially selected for their good health (Mean Age: 71.5; SD: 4.8) were measured on 550 biological and behavioral variables. A Q-Factor Analysis was calculated, using a S by variable matrix, which is the transpose of the common R-Factor Analysis. Sixteen Q-Factors resulted which were then correlated with the original variables so as to give content meaning to each factor. Seven of the 16 derived Q's were associated with verbal intelligence performance. The content of the factors offered a means of describing each S's characteristic functioning. Since the results are extensive, only results on the first Q-Factor were reported. An analysis showed the Ss to be distributed between "haves" and "have nots" in relation to physical and mental well-being. Thus, the "haves" were more intelligent, better adjusted, younger, happier, faster reacting, with better hearing, and healthier. The "have nots" showed evidence of early CNS deterioration. It was concluded that Q-Factor Analysis provides factors through which the individual in a group of aged Ss can be described, thus condensing a large body of data. Analysis of the first factor showed how the Ss can be grouped with specific differentiating characteristics. (Author)

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Use of Q-type Factor Analysis with the Aged*

Morton H. Kleban, Ph.D.
Samuel Granick, Ph.D.
David Meranze, M.D.
Henry Altschuler, Ph.D.

Philadelphia Geriatric Center
5301 Old York Road
Philadelphia, Pa. 19141

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The NIMH supported a long-term study of a small group of healthy aged men. The findings of the study have been reported in two books, the initial report by Birren, Butler, Greenhouse, Sokoloff, and Yarrow (1963) and a subsequent follow-up study by Granick and Patterson (1971).

The present study continues the analytic work on these Human Aging men, using Q-type factor analysis as the method of investigation. Sixteen Q-type principal factors were generated on the 1957 Human Aging data. Q-type factor analysis has demonstrated its utility in previous investigations (Kleban, Brody, Lawton, and Moss, 1975; Brody, Kleban, Waldow and Freeman, 1975; Moss, Kleban, Lawton, and Brody, 1973).

Discriminant analyses were performed on these 16 Q's using criteria of verbal intelligence, performance intelligence, arithmetic intelligence, survival vs. non-survival, presence vs. absence of senility, and good vs. poor health. All criteria returned statistically significant discriminant functions. The present paper is devoted specifically to the verbal intelligence criterion. Seven Q's had significant relationships with it. The paper, however, concentrates exclusively on the verbal intelligence component of Q-1, because half the Human Aging data correlated with it, thus making interpretation and presentation a concerted and pronounced undertaking.

Method

The Human Aging study had 47 male Ss (ages 65 to 92; $\bar{X} = 71$). Refer to Birren, et. al., 1963 for discussions of sample characteristics and research methodology. In the present study, 550 variables were selected from the 1957 data sets for Q-type factor analysis, including

variables from the psychiatric, medical, cerebral circulation and metabolism, psychometric, EEG, auditory, MMPI, Rorschach, intellectual, visual-motor, personality, audiometric, and psycho-social studies.

The following is a capsule description of Q-type factor analysis:

1. The subject X variable matrix was approximately double standardized (Nunnally, 196 ; Cattell, 196).

2. A 47 X 47 correlations matrix was computed; these were correlations among Ss using the 550 variables as entries to the correlations.

3. The correlation matrix was transformed into a matrix of unrotated prinicpal factor loadings. Sixteen Q-type factors were generated, using Cattell's Scree graph and Kaiser's 1.0 eigenvalue criterion.

4. Each Q-type factor was correlated with the 550 variables. These ~~semi-partial~~ correlations indicated which variables covaried with each Q.

In the present study, the 16 Q's were analyzed with respect to verbal intelligence. The Ss had scores on a verbal intelligence factor which was composed of WAIS subtests (information, comprehension, arithmetic, similarities, and vocabulary), the Wisconsin card sort, and two audiometric tests (Kleban, Granick, and Rovine, 1975). The verbal intelligence components were extracted from the Q's by the following method:

1. The verbal intelligence factor divided Ss into 23 negative and 24 positive scores. The brighter Ss had lower scores.

2. Seven Q's had significant F-ratios with the intelligence criterion ($p \leq 0.05$). A stepwise discriminant analysis indicated that each Q had unique, significant variance with the intelligence criterion.

3. A discriminant function was derived across the seven Q's which assigned Ss almost perfectly to their criterion condition.

4. Two types of discriminant function scores were computed: (i) a score derived for each S from the equation; and (ii) seven scores for each S derived from the partial discriminant coefficients.

5. These derived discriminant function scores were correlated with the 550 variables. The correlations with the total discriminant function scores returned very few significant correlations. The process of

summation acted to obscure the unique contributions of the seven Q's. The partial discriminant function scores, however, produced an abundance of significant correlations.

Results

Table 1 cpntains a selection of statistically significant correlations ($r \geq 0.26$, $p \leq 0.05$) between Q-1 and the original variables (249 correlations). Q-1 has a consistent, uniform direction; Ss with higher factor loadings have beeter functioning. The sign of the correlations reflect scale directions of the original variables.

Typically, Q-type factors are not so orderly or well behaved. The other Q's have variables containing contrasting directions. Ror example, Q-2 contrasts verbal intelligence and energy level.

Q-1 divides Ss with respect to brightness-dullness (observe WAIS correlations) and cognitive decline-stability (observe psychiatric ratings). The size of the correlations indicates the extent to which it is represented in Q-1. Brightness-dullness has a pronounced effect; cognitive decline-stability has a more limited role, appearing in a subgroup of bright vs. dull Ss. The confluence emerges throughout the other data sets on Q-1. Verbal intelligence has an awesome influence on the functional and emotional adjustments of these aged men. An incipient drop in cognitive capability in some duller Ss produces strong emotional and functional ramifications.

Associated with the confluence of brightness-dullness and cognitive decline-stability are medical indices of illness-health. Consistent evidence is present of associated pulmonary, cardiac, circulatory, and brain tissue disease. The pathology appears primarily among some duller Ss and probably within those showing evidence of cognitive decline. These decliners appear to be suffering from beginning stages of cerebral arteriosclerosis.

Discussion

Q-type factor analysis is an extremely valuable tool and should have a more extensive application in gerontological research. In fact, it should be the method of choice in small sample, many measurements research conditions.

Ss on Q-1 are divided into two groups: the "haves" and the "have-nots." The "haves" are brighter and some are showing good stability in intellectual functioning. The "have-nots" are truly more limited, with some Ss showing cognitive deterioration. The deterioration appears accompanied by emotional problems. Cognitive losses in dull Ss seems to intensify their adjustment problems. Brighter Ss showing incipient cognitive deterioration do not give evidence of an associated pattern of emotional maladjustment (Kleban, et. al, 1975). They are better able to tolerate cognitive slippage because of their greater intellectual reserves.

The medical variables probably play a causative role with respect to cognitive deterioration. Circulatory insufficiencies are present in both the reception and delivery of oxygen to the brain. Brain cell destruction, moreover, are specified from X-ray studies by the examining physicians.

Q-1 provides a basis for organizing our zero-order correlation studies by Granick, Kleban, and Weiss (1975) on hearing loss and intellectual deficits, Granick, Kleban, and Weiss (1975) on hearing loss and personality problems, and Libow, Granick, Kleban, and Weiss (1975) on hearing loss and medical problems. They all appear to be different aspects of Q-1 and all appear related to the medical condition of cerebral arteriosclerosis.

Table 1

Significant Correlations Of Variables With Q-1 (Verbal Intelligence Aspect)

Low Q-1 Score	High Q-1 Score	Variable	r
		Psychometric & Learning:	
Lower # Digits	Higher # Digits	Speed of Copying Digits	.60
Lower # Words	Higher # Words	Speed of Copying Words	.66
Lower # Letters	Higher # Letters	Verbal Fluency: A. Any Letter	.59
Lower # Words	Higher # Words	Verbal Fluency: S	.62
Lower # Words	Higher # Words	Verbal Fluency: N	.38
Lower # Additions	Higher # Additions	Speed of Addition: 1 Operation*	.50
Lower # Subtractions	Higher # Subtractions	" " Subtraction: 2 Operation*	.45
Lower # Alterations	Higher # Alterations	" " Alteration: 2 Operation*	.57
Slower Reaction	Faster Reaction	Line Diff. (15"): 5% Difference*	-.34
Slower Reaction	Faster Reaction	Reaction Time: Mean*	-.70
Slower Reaction	Faster Reaction	With Shock at Median: Mean*	-.67
Less Intelligent	More Intelligent	WAIS: Information	.69
Less "	More "	WAIS: Comprehension	.69
Less "	More "	WAIS: Arithmetic	.68
Less "	More "	WAIS: Similarities	.72
Less "	More "	WAIS: Digit Span	.46
Less "	More "	WAIS: Vocabulary	.78
Less "	More "	WAIS: Digit Symbol	.67
Less "	More "	WAIS: Picture Completion	.44
Less "	More "	WAIS: Block Design	.64
Less "	More "	WAIS: Picture Arrangement	.68
Less "	More "	WAIS: Object Assembly	.41
Less "	More "	WAIS: Verbal IQ	.80
Less "	More "	WAIS: Performance IQ	.68
Less "	More "	WAIS: Full Scale IQ	.84
Lower Functioning	Higher Functioning	Raven Progressive Matrices	.41
Lower Vocabulary	Higher Vocabulary	Mill Hill Vocabulary: A*	.66
Lower # Correct	Higher # Correct	Verbal Learning Nonsense Words: # Correct 1*	.66
Lower " "	Higher " "	Verbal Learning Meaningful Words*	.56
Lower Recall	Higher Recall	Psychiatric Mental Status: Reading	.30
Lower Intelligence	Higher Intelligence	" " " : Absurdities	.47
Lower "	Higher "	" " " : Opposites	.70
Lower "	Higher "	" " " : Proverbs	.65
Lower "	Higher "	" " " : Information	.56
Lower "	Higher "	" " " : Comprehension	.53

Low Q-1 Score	High Q-1 Score	Variable	r
Lower Intelligence	Higher Intelligence	Psychiatric Mental Status: Calculation	.59
Lower "	Higher "	" " " : Similarities	.67
Lower "	Higher "	" " " : Digit Forward	.67
Lower "	Higher "	" " " : Digit Backward	.46
Lower "	Higher "	" " " : Digit Span	.65
Lower "	Higher "	" " " : Vocabulary	.66
Lower "	Higher "	" " " : Verbal IQ	.67
Lower "	Higher "	" " " : Total	.74
		Dual Channel Audiogram	
Lower Correct Recalls	Higher Correct Recalls	Dichotic Serial Score 1 *	.38
Lower " "	Higher " "	Dichotic Paired Score + 1½ *	.45
Lower " "	Higher " "	Dichotic Paired Partial Score 1 *	.66
Lower Span	Higher Span	Diotic: 2 Span *	.50
More Errors	Less Errors	Diotic Errors: 2 Errors *	-.47
Lower R	Higher R	Rorschach: R	.34
Higher W%	Lower W%	" : W%	-.27
Lower d	Higher d	" : d	.33
Lower ΣM	Higher ΣM	" : ΣM	.48
Lower Σ (M+C)	Higher Σ (M+C)	" : Σ (M+C)	.52
Lower V	Higher V	" : V	.37
Lower Σ (V+Y)	Higher Σ (V+Y)	" : Σ (V+Y)	.46
Lower Percent	Higher Percent	" : (Σ (M+C+V+Y))/R	.41
Higher F%	Lower F%	" : F%	-.43
Lower F+%	Higher F+%	" : F+%	.27
Lower F+%	Higher F+%	" : F+% Extended	.39
Higher A%	Lower A%	" : A%	-40
Lower P% Beck	Higher P%	" : P% Beck	.49
Lower # Content	Higher # Content	" : Number of Other Content	.47
Lower Z	Higher Z	" : Z	.27
Higher N%	Lower N%	" : N%	-40
Lower H%	Higher H%	" : H%	.39
Lower E HAB%	Higher E HAB%	" : E HAB%	.20
		MMPI:	
Higher F Score	Lower F Score	F Score	-.57
Higher Hysteria	Lower Hysteria	Hysterical	-.33
Higher Depression	Lower Depression	D	-.40
Higher Psychosthemia	Lower Psychosthemia	Pt	-35
Higher Schizophrenia	Lower Schizophrenia	Sc	-35

8

Low Q-1 Score	High Q-1 Score	Variable	r
		Psychiatric	
Higher Decrease	Lower Decrease	Progressive Decrease of Intellectual Function	-58
Higher Chilishness	Lower Childishness	Childish Emotionality	-50
Incoherence	Relevance	Relevance: Incoherence	-42
More Self-centered	Lower Self-Centered	Self-centered	-33
More Difficulty	Lower Difficulty	Difficulty Assimilating New Experience	-38
More Complaints	Little Complaints	Complaints of Weakness: Exhaustion - Mood	-41
More	Less	Patchy Performance	-39
Many	Few	Perseveration of Ideas	-43
Yes	No	Impaired Recent Memory	-66
Yes	No	Impaired Remote Memory	-33
Yes	No	Confabulation	-28
Concrete	Generalize	Ability to Generalize vs. Concrete	-68
Yes	No	Impaired Judgment	-41
Yes	No	Difficulty in Maintaining Attention	-38
Yes	No	" " " Set	-44
High Value	Low Value	Total of Preceeding Variables	-60
Yes	No	Depressive Trend	-49
Yes No	No	Separate Response---Anxiety	-28
Feels Old	Recognizes Age	Futurity: Recognition of Aging Process	-27
Planning	No Planning	Plans for the Future	-29
Frightened or Depressed	Indifferent or Optimistic	Is he .... About the Future?	.50
No After-Life	Yes	Does he Envisage an After-Life?	.45
No	Yes	Has he made specific provisions for death?	.32
Problem	No Problem	Interview: Pleasure	-32
Problem	No Problem	" : Assertiveness	-38
Complaint	Active	" : Compliance - Active	.34
Problem	No Problem	" : Use of Fantasy	-31
Lower Use	Higher Use	" : Integrating	.60
Problem	No Problem	" : Disintegrating	-41
Present	Absent	Senile Factor: Impaired Recent Memory	-45
"	"	" " : " Intellectual Function	-52
"	"	" " : " Abstraction	-.61
"	"	" " : Attention Difficulty	-49
"	"	" " : Set Difficulty	-46
"	"	" " : Impaired Remote Memory	-35
"	"	" " : Impaired Judgment	-58
"	"	" " : Confabulation	-37
"	"	" " : Disorientation	-35
"	"	" " : Marked Lability	-25
Higher Score	Lower Score	" " : Total Changes	-72

Low Q-1 Score	High Q-1 Score	Variable	r
Present	Absent	Presence of Senile Quality	-47
Lower Morale	Higher Morale	Index Morale	.42
Fair - Pocr	Excellent - Very Good	Composite Adaptation Score	-40
Higher Psychopathology	Lower Pathology	Psychopathology: New	-31
Present	Absent	Psychological Isolation	-38
Higher Tendency	Lower Tendency	Predicted Emotional Breakdown	-41
		Audiograms	
Higher Thresholds	Lower Thresholds	Click Perception 1 cps Threshold	.67
" "	" "	" " 2000 cps "	.67
Lower Hearing	Better Hearing	Audiometric - Right 125	-55
" "	" "	" " 250	-53
" "	" "	" " 500	-63
" "	" "	" " 1000	-67
" "	" "	" " 1500	-71
" "	" "	" " 2000	-75
" "	" "	" " 3000	-68
" "	" "	" " 4000	-59
" "	" "	" " 6000	-71
" "	" "	" " 8000	-66
" "	" "	" Left 125	-49
" "	" "	" " 250	-48
" "	" "	" " 500	-51
" "	" "	" " 1000	-63
" "	" "	" " 1500	-65
" "	" "	" " 2000	-66
" "	" "	" " 3000	-47
" "	" "	" " 4000	-46
" "	" "	" " 6000	-54
" "	" "	" " 8000	-56
		Medical	
Higher White Count	Lower White Count	Hematology: While Blood Count	-26
Lower Monocytes	Higher Monocytes	Diff. Count: Monocytes (Lymphocytes)	.28
" Albumin	" Albumin	Albumin	.31
" Beta 1	" Beta 1	Electrophoresis Beta 1 Globulin	.40
Abnormal	Normal	Skull X-ray: Non-vascular	-44
"	"	Chest X-ray: Heart Size	-36
"	"	" " : Aortic Calcification	-44
"	"	" " : " Pulsation	-.27
"	"	" " : Lung Field Calcification	-28
"	"	" " : Other Pulmonary Lesions	-38

Low Q-1 Score	High Q-1 Score	Variable	r
Abnormal	Normal	Physical Exam: Increased AP Diameter of Chest	-27
"	"	" " : Angiomata of Skin	-30
Lower TVC	Higher TVC	Pulmonary Function: Total Vital Capacity	.40
" MBC	" MBC	" " : Maximum Breathing Capacity	.48
Heavy Smoking	Less Degree Smoking	Medical History: Smoking History	-.25
Longer History	" History	" " : Smoking Duration (Years)	-34
" Drinking History	Less Drinking History	" " : Alcohol Intake (Years)	-44
Frequent - Regular	None - More	" " : Uses Laxatives	-38
Higher Pressure	Lower Pressure	Blood Pressure: Systolic - 8 AM	-45
" "	" "	" " : " 8 PM	-48
" "	" "	" " : " Overall	-48
" "	" "	Pulse " : 8 AM	-50
" "	" "	" " : 8 PM	-59
" "	" "	" " : Overall	-.57
" "	" "	" Pressure/Age: 8 AM	-33
" "	" "	" " " : 8 PM	-37
" "	" "	" " " : Overall	-38
Less Weight	More Weight	Weight	.29
Older Age	Younger Age	Age	-43
		Brain Chemistry	
Higher Blood Pressure	Lower Blood Pressure	MABP: Mean Arterial Blood Pressure	-43
" Resistance	" Resistance	CVR: Cerebral Vascular Resistance	-32
Lower $CMRO_2$	Higher $CMRO_2$	$CMR(O_2)$ Cerebral Oxygen Consumption	.37
		Psycho-Social	
Semi - & - Retired	Not Retired	Retirement	-32
Loss of Significant Supports	Significant Supports	Social Environments Supports & Losses	-44
Disatisfied, Unhappy	Satisfied, Interested	Attitudes Daily Behavior	-43
Activities are few	Many Activities	" " " (Org. Behavior)	.58
Excludes a future	Maintains a future	Goal Characteristics	-36
Passive	Active	Activity Level	.28
Does Not Take Initiative	Takes Initiative	Social Initiative	-.33
Very few & Not Frequent	Many, Frequent, regular	Social Field Beyond Household	.42
Foreign Born	Native	Foreign Born - Native	-49
Less Education	Higher Education	Education	.47
Lower Income	Over $5,000	Income: Absolute Terms	-.27
Same Standard of Living	Subjective Drop in Standard	" : Subjective Terms	.28
Completely Independent in Self	Some Assistance From Family	Economic Independence	.32

* Asterisk indicates that the single variable is representing a cluster of related variables.

$p \leq .05$, $r \geq .27$